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I, MICHAEL SHEEHAN, EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003905127 for a patent by ULTRA AQUATIC TECHNOLOGY PTY LTD as filed on 22 September 2003.

WITNESS my hand this
Twenty-third day of April 2010

M Sheehan

MICHAEL SHEEHAN
EXAMINATION SUPPORT AND SALES

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ULTRA AQUATIC TECHNOLOGY PTY LTD

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PROVISIONAL SPECIFICATION FOR THE INVENTION ENTITLED :

METHOD AND APPARATUS FOR COLLECTING AND SEPARATING SOLIDS FROM LIQUIDS

This invention is described in the following statement :-

METHOD AND APPARATUS FOR COLLECTING AND SEPARATING SOLIDS FROM LIQUIDS

Technical Field

This invention relates to a method and apparatus for collecting and separating solids from liquids and in particular to a method and apparatus for collecting and separation of solids as well as surface scum from liquids as well as solids such as sludge settling in a liquid.

Background Art

In many situations it is either desirable or necessary to separate solids or other materials from liquids. For example, in aquaculture ponds, there tends to be, over a period of time, an increase in solid matter in the pond water which may be undigested food, excrement from fish or crustaceans being grown in the ponds or any other form of organic and inorganic solid material. As a result of the build up of this solid matter, it is necessary to empty the pond at regular intervals usually at harvest time which creates an environmental problem in liquid disposal. Further heavy machinery is usually required to be used at considerable cost to remove and spread the solid matter which has settled as sludge on the base of the pond. The pond is then required to be refilled necessitating use of a large quantity of water. Where the aquaculture system uses fresh water, refilling of the pond provides a drain on natural resources and therefore is becoming environmentally unacceptable. It would be advantageous therefore to reduce the frequency at which changing the pond water in aquaculture systems is undertaken. It would also be advantageous to remove or contain the sludge in the effluent water from agricultural ponds to reduce the effects of solids discharge into the natural waterways and contain and/or remove the sludge or solid wastes from with the pond prior to discharge.

Summary of the Invention

The present invention aims to provide in one aspect a method and apparatus for separating solids from liquids and in particular to a method and apparatus which is particularly but not exclusively suited for application to the separation of solids from liquids in which the solids are floating or suspended in liquid and/or settling as sludge in a liquid. The present invention in a further particular aspect aims to provide a method and apparatus for cleaning ponds such as aquaculture ponds. Other objects and advantages of the invention will become apparent from the following description.

Reference to "solids" in the following description includes solids or other

materials which are entrained in liquids including coarse, fine, suspended and settleable solids, and solids or other materials floating on liquids or other gross pollutants as well as scum, foam or other organic or inorganic pollutants at the surface of a liquid.

The present invention thus provides in a first preferred aspect, a method of separating solids from a moving liquid, said method including the steps of providing in the path of movement of said liquid, separation apparatus, providing float means for supporting said separation apparatus adjacent the level of liquid, and direction flowing liquid into said separation apparatus for separation of solids in said liquid in said separation apparatus.

In accordance with the method of the invention, liquids entering the separation apparatus are cause to flow along a circular path such that solids carried by the liquid concentrate and collect in a central region of the separation apparatus from which they can be subsequently removed.

The present invention in a further preferred aspect, an apparatus for separating solids from liquids, said apparatus including a housing defining a collection chamber, buoyant support means for supporting said housing adjacent to the surface of said liquid, and at least one entry port into said housing whereby liquid and entrained solids can flow into said chamber for collection.

The housing is preferably circular in plan view and means are suitably provided for directing liquids in a tangential direction into the housing. The housing suitably includes a side wall and the at least one entry port is formed in the side wall. The means for directing liquid into the housing may include a guide member or scoop extending from the entry port. The guide member suitably extends from one end of the entry port. A further guide member suitably extends from the other end of the entry port. The guide members may define a throat to assist in direction liquid into the housing. The housing suitably is in a generally cylindrical configuration but may have a frustoconical configuration with the side wall inclined inwardly from to the upper end. The housing also suitably includes one or more outlet ports or openings spaced from the inlet port for passage of liquid out of the housing.

The housing suitably has a sump on its lower side in which solids passing into the housing may collect. Preferably, the housing is of a frustoconical configuration. A pump such as a sludge pumping device may be used to pump solids collecting in the sump away from the housing. The sludge pumping device or an inlet to a sludge pumping device may be permanently or temporarily positioned in the sump.

The buoyant support means may comprise an elongated member located around at least portion of the upper periphery of the housing. The elongated member may define an elongated hollow chamber which may be sealed to defined one or more air reservoirs. Alternatively or additionally a plurality of buoyant bodies such as foam plastics bodies may be located in the elongated hollow chamber. The hollow chamber may be circular or rectangular in cross section and the buoyant bodies may be tubular bodies for neat receipt in the hollow chamber. In a further alternative arrangement, a buoyant foam plastics material may be injected into the hollow chamber.

The buoyant support means however may comprise any form of buoyant body or bodies which will support the housing at or adjacent the surface of liquid in which the apparatus is located. For example the buoyant support means may comprise a foam filled plastic moulded housing or housings. The buoyant body or bodies may be arranged at spaced locations around the housing and fixedly or detachably mounted thereto.

The apparatus may include means for mooring or locating the apparatus in a desired position on a body of liquid. The locating means may include an aperture through which a stake or the like may be driven. The apparatus may also include means for facilitating interconnection with a further like separation apparatus whereby a number of apparatuses may be arranged in an array to improved the efficiency of collection. Such means may comprise arms extending from the housing, suitably radially from the housing and means may be provided for releasably coupling one or more arms of one housing to one or more arms of an adjacent housing.

Means may be provided for assisting in guiding liquid and materials in the liquid towards the entry port of the apparatus. Such means may include guide or deflector arms which extend outwardly of the apparatus. The guide arms may comprise floating boom arms which may be angled as desired relative to the apparatus. A series of interconnected guide arms may be provided to guide liquid flow towards the separation apparatus. The guide arms may be arranged in any configuration.

The present invention in a further aspect provides sludge collection apparatus for removing sludge or other materials collecting at the base or bottom of a water reservoir, said sludge harvesting apparatus including a hollow suction head, at least one outlet duct extending from said hollow suction head, and means for introducing air into said suction head to assist in moving said sludge or other materials along said duct.

The means for introducing air into the suction head suitably comprises an air

diffuser pipe connected to a supply of air. The air diffuser pipe suitably includes a plurality of air outlets. This technique uses the engineering principles of air lift pumping to move the liquid and sludge entrained within the liquid.

The sludge collection apparatus is suitably associated with the above described separation apparatus to form a sludge harvester. Preferably, link means interconnect the suction head of the sludge collection apparatus and the separation apparatus. The link means suitably permits the suction head to be moved towards and away from the separation apparatus.

Preferably, the at least one outlet duct is connected to the separation apparatus whereby the separation apparatus may collect and concentrate materials from the bottom of the water reservoir. The separation apparatus may also simultaneously collect solids in or adjacent the surface of the water. Preferably the at least one outlet duct passes into the entry port of the separation apparatus.

Any suitable means may be provided for moving the sludge harvester. Such means may comprise a winching system comprising a winch having a cable coupled to the suction head to move the suction head and attached separation apparatus around the water reservoir. Alternatively, the winching system and cable can be attached to the separation apparatus.

The present invention in a further aspect provides a method of cleaning a water reservoir such as an aquaculture pond, said method including the steps of providing sludge collecting means, and moving said sludge collecting means about the bottom of said reservoir for collection of materials settling on the bottom of said reservoir.

The cleaning method of the invention preferably also includes the steps of providing solid collecting apparatus for collecting solids floating on or located adjacent the surface of liquid in said reservoir and moving said solids collecting apparatus around the surface of liquid in said reservoir.

Preferably, the sludge collecting means and solids collecting apparatus are operated simultaneously. Most preferably, the sludge collecting means and solids collecting apparatus are interconnected so as to be movable simultaneously about said liquid reservoir.

In yet a further aspect, the present invention provides a method of cleaning a liquid reservoir, said method including the steps of removing materials settling on the bottom of said reservoir and simultaneously collecting solids floating in or on the surface of the liquid in said reservoir.

Brief Description of the Drawings

In order that the invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate preferred embodiments of the invention and wherein :-

Figs. 1 and 2 are opposite perspective views of a first form of separation apparatus according to an embodiment of the present invention;

Figs. 3 to 5 are a front view, top view and perspective view from below of the housing of the separation apparatus of Figs. 1 and 2;

Figs. 5 and 6 illustrate the scoops of the separation apparatus;

Fig. 7 illustrates the outlet member of the separation apparatus;

Figs. 9 and 10 illustrate the floatation members of the separation apparatus;

Fig. 11 illustrates the manner in which two separation apparatuses may be interconnected;

Fig. 12 is a perspective view of a sludge harvester according to another aspect of the invention;

Fig. 13 is an exploded view of the suction head of the sludge harvester of Fig. 12;

Fig. 14 is a perspective view from the underside of the suction head of the Fig. 9;

Fig. 15 illustrates the air diffuser used in the suction head;

Fig. 16 illustrates the manner of use of the sludge harvester in a sludge collection system of a aquaculture pond; and

Fig. 17 illustrates a typical winch for used in the system of Fig. 16.

Detailed Description of the Preferred Embodiment

Referring to the drawings and firstly to Figs. 1 and 2, there is illustrated separation apparatus 10 according to a first embodiment of the invention. The apparatus 10 includes a main housing or vessel 11 which in this embodiment is of a generally circular configuration in plan view having an open upper side 12, an outer cylindrical side wall 13 which extends upwardly from a lower frustoconical sump 14. A liquid entry port 15 (see Figs. 3 to 5) is formed in the side wall 13, the entry port 15 in this embodiment being of elongated rectangular configuration extending in a generally circumferential direction, in this case 45° around the wall 13. Guide members or scoops 17 and 18 are provided at opposite ends of the entry port 15 to assist in directing liquid carrying solids to be separated into the interior of the housing 11. The guide member 17 as shown more clearly

in Fig. 6 comprises a curved baffle which when installed has a portion 19 which curves outwardly from the entry port 15 such that liquid is directed in a generally tangential direction into the interior of the housing 11.

The guide member 17 also has a portion 20 co-extensive with the portion 19 which extends inwardly of the port 15 to assist in guiding liquids flowing into the housing 11 through the port 15 in a circular direction and around the interior of the housing 11. The other guide member or scoop 18 as shown in Fig. 7 has a leading hooked portion 21 which hooks about the trailing edge of the port 15 and curves outwardly and rearwardly therefrom on the outside of the housing 11 to assist in aerodynamic flow of liquid past the port 15. The guide members or scoops 17 and 18 however may of course be of configurations other than that illustrated.

The wall 13 of the housing 11 is also provided with an outlet opening 22 at a position spaced circumferentially from the entry port 15 and located beneath the portion 19 of the guide member 17 when the latter is installed. The guide member 17 however directs liquid entering the port 15 away from the outlet opening 22 to prevent disruption of the continuous directional movement of the liquid within the housing 11. A plate 23 having series of openings 24 therein defined by inwardly directed flaps 25 bent out of the plate 23 is mountable to the side wall 13 over the outlet opening 22 such that the flaps 25 extend into the housing 11. The flaps 25 serve to direct the liquid circumferentially within the housing 11 whilst the openings 24 act as exits for liquid from the housing 11. The openings 24 may be of different configurations and position depending upon from what level liquids are to exit from the housing 11. The openings 24 may also be adjustable in size and further the flaps 25 may be adjustable or movable. The plates 23 containing the openings 24 and flaps 25 may be interchangeable with other plates 23 having openings 24 and flaps 25 of different configurations depending upon requirements.

The upper end 13 of the housing 11 may be provided with a stiffening collar like flange 26 which substantially encircles the upper end 13 of the housing 11. So as to enable materials floating on the surface of the liquid to enter the housing 11, the flange 26 terminates on either side of the entry port 15 or is cut away above the entry port as at 27.

So that the separation apparatus 10 can float on or adjacent the surface of liquid in which it is operating and from which solids are to be separated, an elongated curved upper hollow float member 28 (see also Fig. 9) extends part way around the housing 11

and terminates at opposite sides of the entry port 15 adjacent opposite sides of the cut-out or missing portion of the flange 26. A further elongated curved hollow float member 29 (see Fig. 10) is fixed to the housing 11 beneath the entry port 15 to provide buoyant support in the region where the upper float member 28 is absent. The float members 28 and 29 can serve as air reservoirs and which for this purpose are sealed or closed at each end. Alternatively, one or more buoyant bodies such as foam plastics members or inserts such as members or inserts of tubular configuration may be located in the hollow members 28 and 29. In an alternative arrangement, a buoyant foam plastics material may be injected into the hollow members 28 and 29. The buoyant support provided by the float members 28 and 29 will support the apparatus 10 in a substantially horizontal attitude at or adjacent the surface of the liquid and with the central axis of the housing 11 substantially vertical.

The apparatus 10 in this embodiment is further provided with a four radially extending arms 31 which extend from the upper float member 28 for facilitating connection between adjacent apparatuses 10 or for mooring the apparatus 10 at a desired location. For this purpose, the free ends of the arms 31 are apertured at 32 to enable interconnection of arms 31 of adjacent apparatuses 10 by suitable connectors links 33 and 34 or for the receipt of anchoring stakes which are driven through apertures 32 and into the floor of the reservoir in which the apparatus 10 is located.

In use, the apparatus 10 is positioned in the path of flow of liquid such that liquid carrying solids to be separated therefrom will flow into the entry port 15 with the guidance of the guiding members 17 and 18. Stakes may be driven through the apertures 32 into the bottom of the liquid reservoir to anchor the apparatus 10 in the desired position. Alternatively, the apparatus 10 may be anchored or positioned by means of mooring lines, anchors or other restraining means. Where the apparatus 10 is arranged within an aquaculture pond, it may be positioned in the path of liquid flow created for example by a rotating paddle wheel type aerator as commonly used in aquaculture.

Liquid being directed into the entry port 15 will flow into the interior of the housing 11 undergoing a circular motion around the internal periphery of the housing 11. Solids entrained in the liquid will tend to be concentrated and settle downwardly and inwardly towards the sump 14. Liquid flowing into the port 15 after passing around the interior of the housing 11 will then escape through the outlet openings 24.

At regular intervals, collected and concentrated solids in the sump 14 may be

removed by use of a sludge pump which is positioned, or which has an inlet placed, within the sump 14. This task may be simply undertaken by persons on a boat or other watercraft which can approach the apparatus 10 floating on the surface of the liquid to enable for cleaning and collection of solids therefrom.

In another arrangement, the apparatus 10 may be moved to the bank of the pond or other body of liquid in which the apparatus 10 is operating to permit removal of the collected solids by a land based sludge pump for example a pump carried by a tractor and/or trailer or other vehicle which may be moved to an appropriate position on the pond bank. Solids removed from the apparatuses 10 may be then taken away by the tractor and/or trailer or other vehicle.

A series of individual separation apparatuses 10 may be arranged at any position where separation of solids from liquids is required. Apparatuses 10 may be arranged in a straight line in a linear array with the apparatuses 10 interconnected by the arms 31 on opposite sides and by means of the connecting links 33 and 34. The connected apparatuses 10 are arranged such that the entry ports 15 are all located on a common side. The array may extend transversely to the direction of liquid flow such that the spaced entry ports 15 all intercept the flowing liquid which is directed into each apparatus 10 for separation of solids as before.

Apparatuses 10 may also be interconnected in a square array again by the arms 31 with inlet ports 15 been arranged on opposite sides of the array for receiving liquid flowing in opposite directions towards the array. This configuration is particularly suited for use in tidal situations where flow of liquid reverses and such that the array can collect solids and other materials both on incoming tidal flow and outgoing tidal flow. Of course, the apparatuses 10 may be connected together in many different arrays other than those described above.

The separation apparatuses 10 of the invention may be used in many different applications where solids are required to be separated in situ or in field locations such as in mining, chemical treatment, manufacturing, or abattoir effluent ponds, agricultural applications such as piggeries, dairies, poultry farms and animal feed lots as well as for maintenance of the health of recreational ponds or lakes at golf course, council parks, and residential canal developments.

Deflector arms may be used in association with the separation apparatus 10 for assisting in directing liquids and solids carried thereby towards the separation apparatus 10. The deflector arms may be formed of a buoyant material or include air chambers or

hollow chambers which may be injected with buoyant foam plastics material or may carry inserted buoyant foam plastics sections or other buoyant materials or bodies to enable the arms to float or be located adjacent the surface of the liquid. Alternatively, separate floats may be attached to the arms for this purpose. Opposite ends of the arms may be provided with apertures to enable connection of the arms at one end to the arms 31 of the separation apparatus 10 by suitable connectors provided through the apertures for example locking pins. The arms may be angled as desired relative to each other and the separation apparatus 10 for directing liquids towards the entry port 15 of the apparatus 10. The arms thus are arranged to define an enlarged throat. This may be extended by connecting further similar arms to the arms.

To facilitate the removal of algae, sludge or other material settling on the floor of the water reservoir, the separation apparatus 10 may be associated with a suction head assembly 40 as shown in Fig. 12 to form a sludge harvester 41. The suction head assembly 40 includes a hollow domed suction head 42 (see also Figs. 13 and 14) which has an open mouth 43 on its lower side and which on its upper side is provided with a series of hollow connecting spigots 44 for connection to uptake tubes 45 which at their upper end extend into the intake port 15 of the apparatus 10. Opposite ends of the suction head 42 are connected to skid arms 46 which are curved upwardly at opposite ends and which support the suction head 42 for movement over the reservoir floor. Opposite link arms 47 are pivotally connected at opposite ends at 48 and 59 to the apparatus 10 and suction head assembly 40 such that the suction head assembly 40 can move with the separation apparatus 10 with the pivotal link arms 47 permitting movement of the separation apparatus 10 and suction head assembly 40 towards and away from each other for example where the surface on which the suction head 40 is operating is undulating relative to the surface of liquid on which the apparatus 10 is floating.

An elongated air diffuser pipe 50 (see Figs. 14 and 15) having a plurality of apertures 51 therein extends longitudinally of the suction head 42 and extends through the wall of the suction head 42 for connection at one or both ends at 52 to air supply tubes 53. The air supply tubes 53 are coupled to air compressors, pumps or blowers 54 which are suitably electrically operated air compressors mounted on respective arms 31 of the separation apparatus 10. Alternatively, the air compressors, pumps or blowers 54 may be mechanically operated such as by being coupled to an internal combustion engine or engines mounted on the separator 10 such that the separator 10 is self

contained. A brush 55 may also be provided around the mouth of the suction head 42 to assist in displacing and containing materials to be collected by the suction head 42. The brush 55 however may also be in the form of a skirt, preferably a flexible skirt which extends around the mouth of the suction head 42.

In use, air is supplied to the air supply tubes 53 by the air compressors 54 which thus passes out of the diffuser pipe 50 through apertures 51 as bubbles into the head 42 to pass upwardly along the uptake tubes 45. This will create a back pressure within the head 42 and serve as an air lift to draw liquid and entrained solids into the spigots 44 for passage upwardly through the ducts 45 to pass out of the outlet ends of the ducts 45 into the port 15 and thus into the housing 11 of the apparatus 10 where solids can be separated and collected in the interior of the housing 11 for subsequent disposal.

The sludge harvester 41 comprising the separation apparatus 10 with attached suction head assembly 43 is most suitably used by being moved around the body of liquid in which it is operating. A typical arrangement for operating the sludge harvester 41 in an aquaculture pond 55 is illustrated in Fig.16. In this arrangement, a winch 56 (shown in Fig. 7) is provided on one bank of a reservoir either fixedly mounted or mounted for movement along the bank. A cable 57 extending from the winch 56 has one end 58 coupled to the suction head assembly 40 typically by means of a bridle. The other end 59 of the cable 57 passes above water and is guided over the separation apparatus 10 and passes around a pulley block 60 to be coupled to the opposite side of the suction head assembly 40. An electrical cable 61 for supply current to the air compressors 54 may be hung from the cable 57.

In use the winch 56 is operated in opposite directions as indicated by the arrows A to move the suction head assembly 40 and attached separation apparatus 40 across the floor of the pond 55 whilst the compressors 54 are supplied with current. Sludge on the floor of the pond 55 will be drawn upwardly along the uptake pipes 45 under the influence of the air supplied to the air diffuser pipe 50 to collect within the separation apparatus 40 where it is concentrated at the center of the apparatus 40. At the same time, the separation apparatus 10 is moved over the surface of the water of the pond 55 to collect solids on or near the surface of the water.

At regular intervals, the sludge harvester 41 may be moved to either bank of the pond 55 to allow removal of the sludge and other solids or materials concentrating in the apparatus 10.

The winch 56 may be moved along the bank in the directions B and the pulley

block 60 on the opposite bank correspondingly moved to allow other areas of the pond 55 to be dredged. For this purpose, the winch 56 may be mounted on a mobile carriage and the pulley block 60 may be similarly mounted.

For increased efficiency of operation, a ganged series of sludge harvesters 41 may be joined in a side by side configuration as illustrated in dotted outline in Fig. 16 to allow an increased area of the floor of the pond to be traversed.

Whilst the suction head assembly has been described in connection with the separation apparatus 10, it may be used with any other form of separation apparatus. Alternatively, the suction head assembly 41 may be used independently. Further other arrangements may be provided for moving the sludge harvester 41 in or on a body of water.

The components of the apparatus 10 are preferably formed of plastics materials but may be formed of metal suitably a non-corrosive metal. The dimensions of the main housing may be scaled up or down to address water volume, flow rates and depth. Water entry or exit points may be modified to allow for different water flow directions, volumes and flow rates. The depth and position of the outlet ports 29 may also be adjusted in accordance with the types of solids, floating or settling, to maximise retention of solids. Thus with floating solids, the ports 29 may be lowered so that the solids are retained within the apparatuses 10 and 34 whilst with settling solids, the ports 29 may be raised. Mooring points may be redesigned to allow better anchoring or joining of other units for form multiple connected units.

Flotation of the device may require alterations to allow adjustment of in-water height levels or increased volume to allow persons to access central regions for maintenance or servicing. The float members 28 and 29 may be replaced by separate floatation elements such as foam blocks or alternatively, the housing may be supported on floating rafts or other buoyant body. Buoyant chambers may also be formed as part of the housing for example by being integrally formed with the housing 11.

The apparatus of the invention is lightweight, corrosion resistant and non-toxic and not polluting. The apparatus may be made from recycled plastics and colour coded for a variety of applications for descriptive requirements. The separation apparatus is a passive apparatus not requiring any electrical or mechanical power input. Further the apparatus is solid state and modular. The apparatus could be designed for use with toxic or corrosive liquids and be stackable for ease of handling or freighting purposes. The apparatus may be easily replicated for mass production for example by moulding the

housing and collection unit from plastics such as in a rotational moulding process. The apparatus is easily transportable and relocatable for use at different locations with ease of set-op, operate, break down and removal for time/ labour requirements.

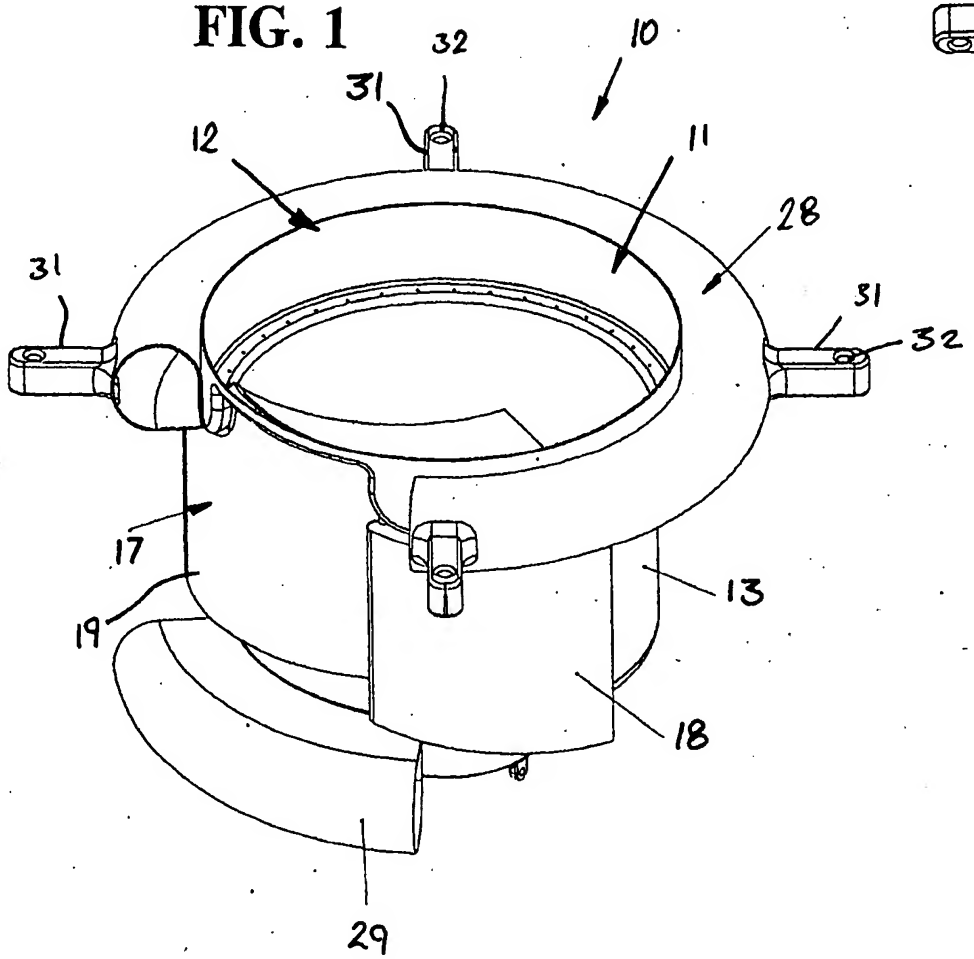
Whilst the above has been given by way of illustrative embodiment of the invention, all such variations and modifications thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as herein set forth.

Dated this twenty-second day of September 2003

ULTRA AQUATIC TECHNOLOGY PTY LTD
By Their Patent Attorney

JOHN R G GARDNER

FIG. 1



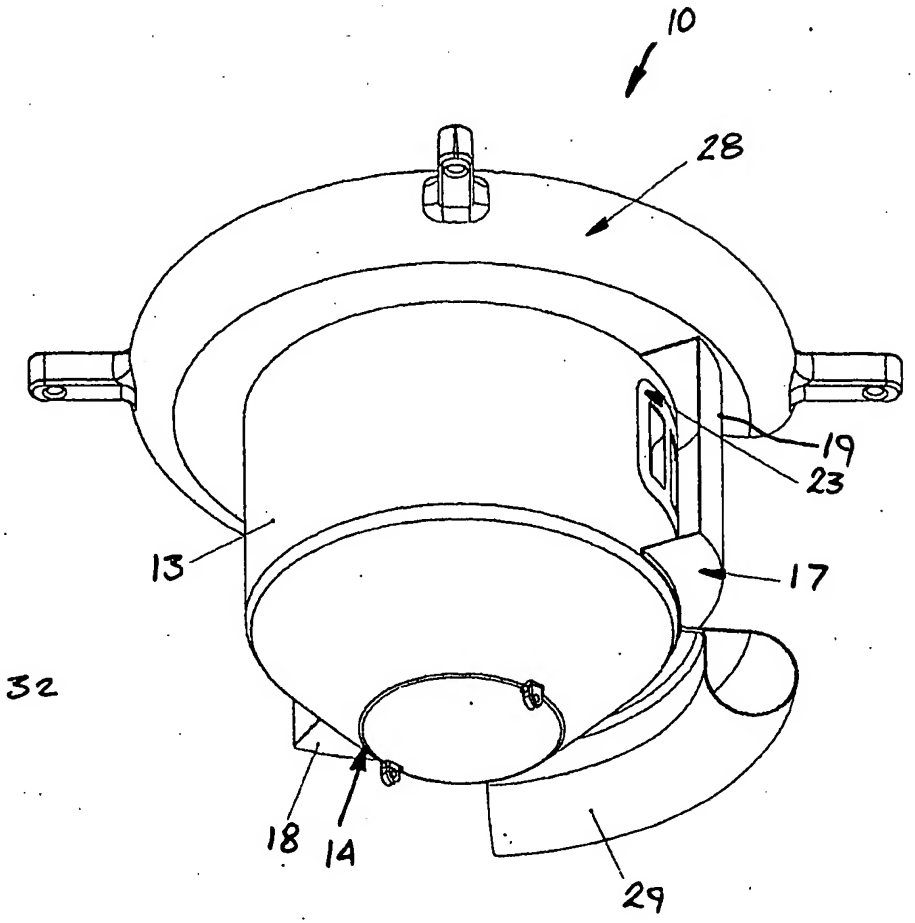


FIG. 2

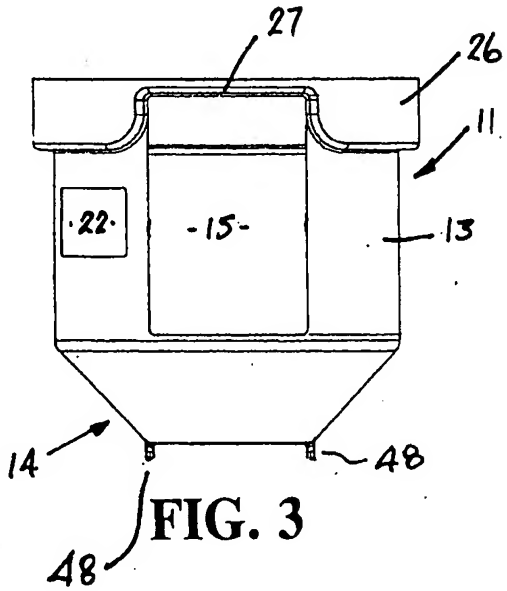


FIG. 3

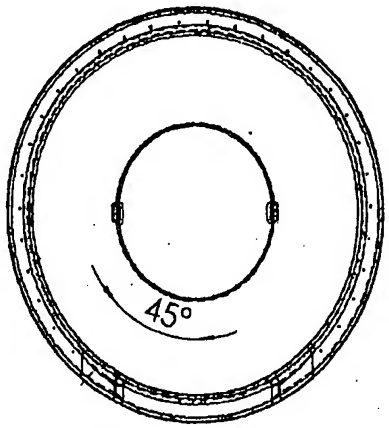


FIG. 4

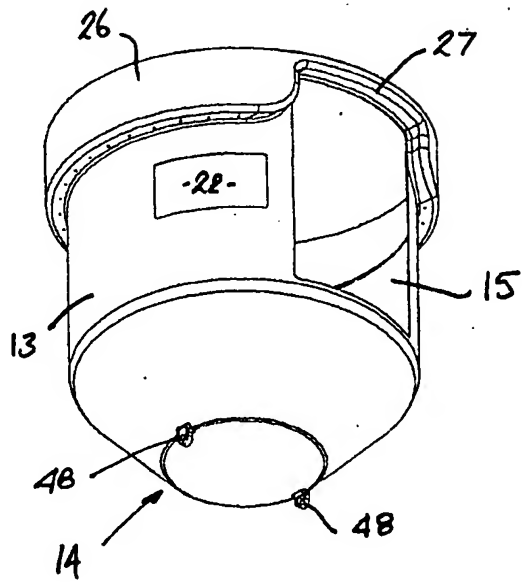


FIG. 5

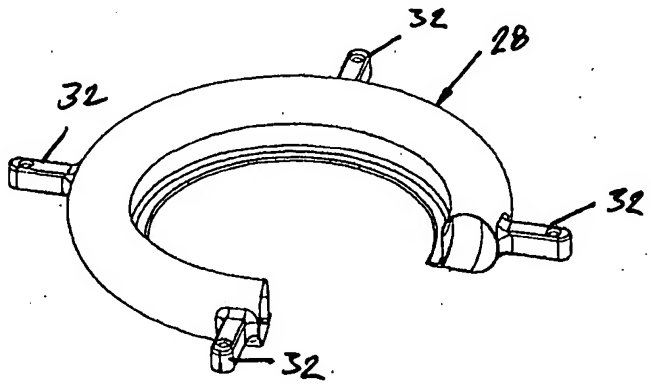


FIG. 9

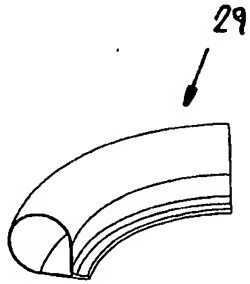


FIG. 10

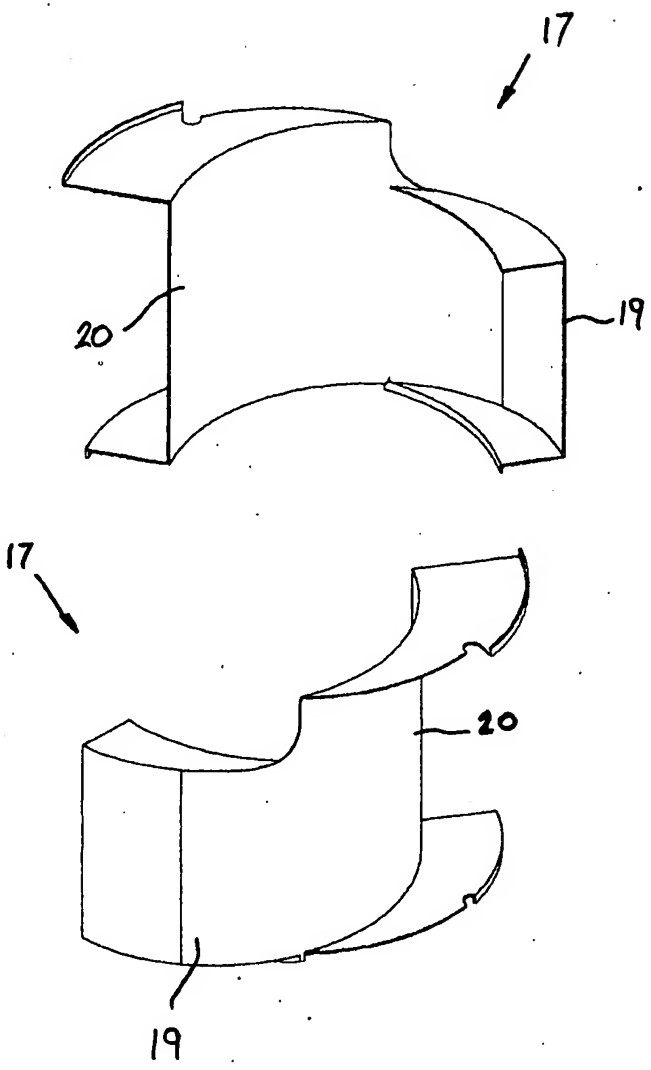


FIG. 6

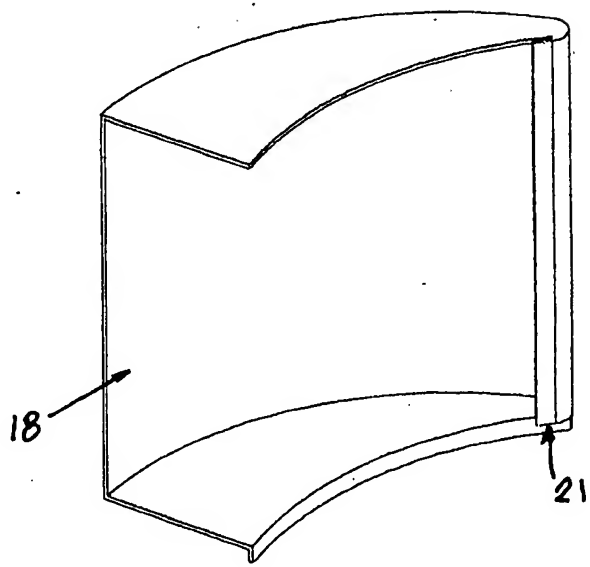


FIG. 7

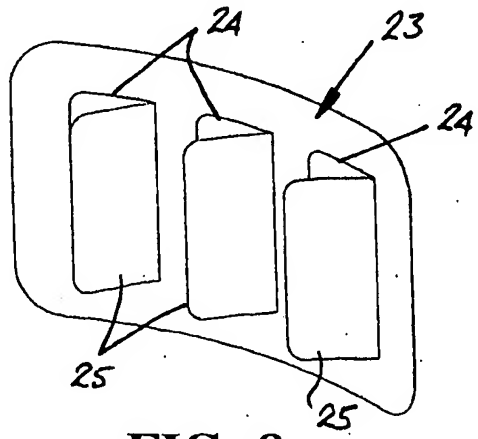


FIG. 8

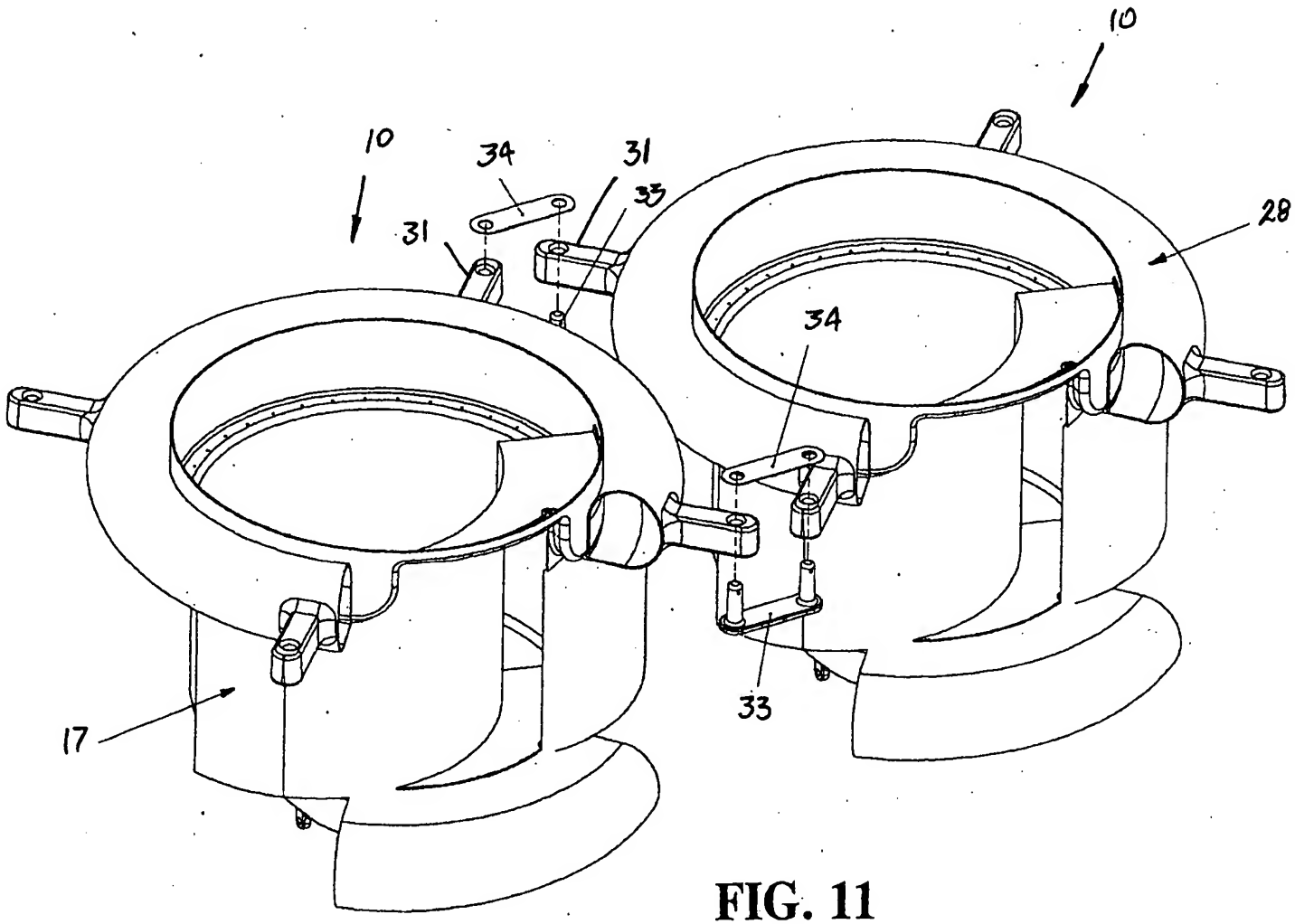


FIG. 11

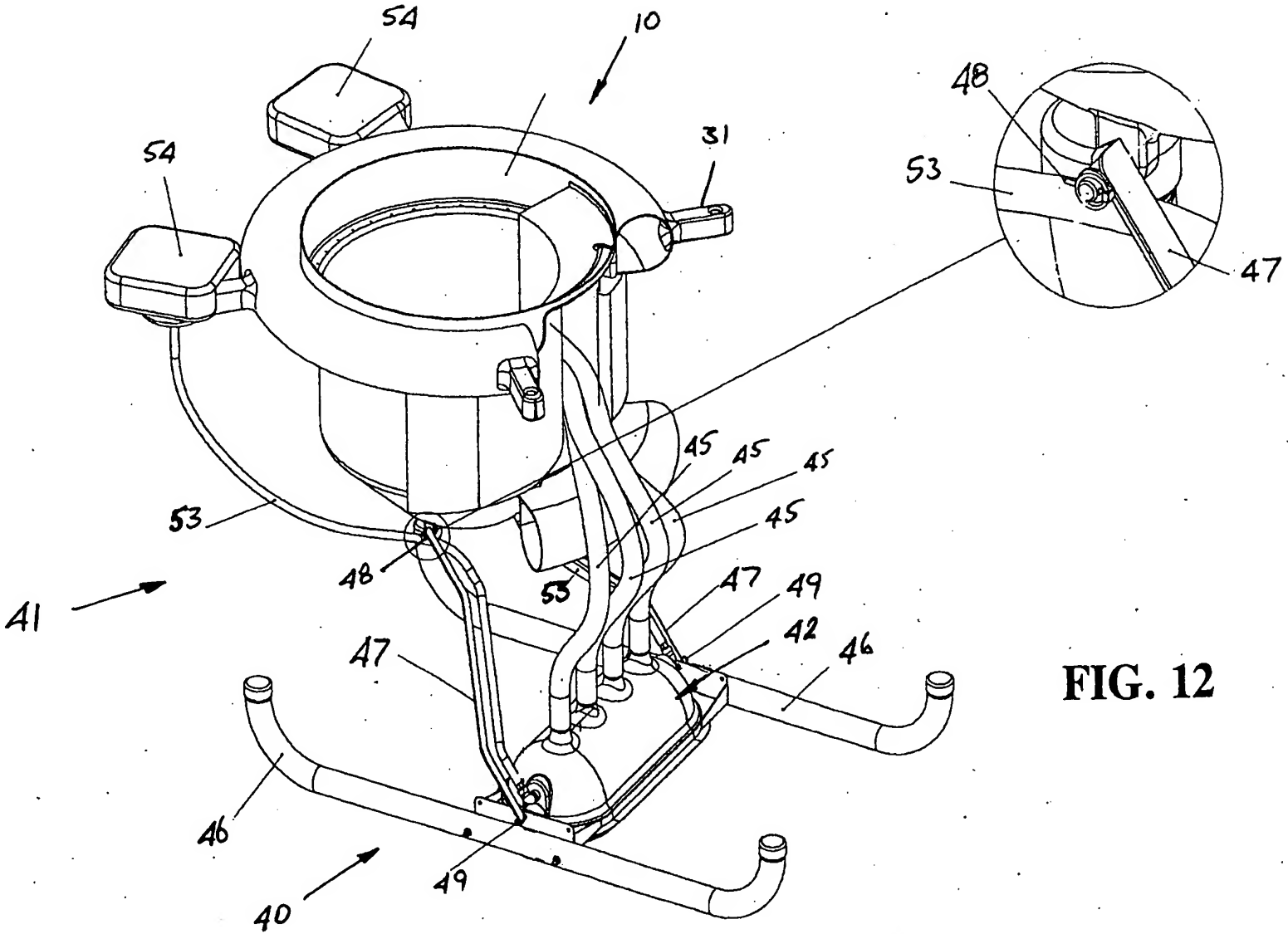


FIG. 12

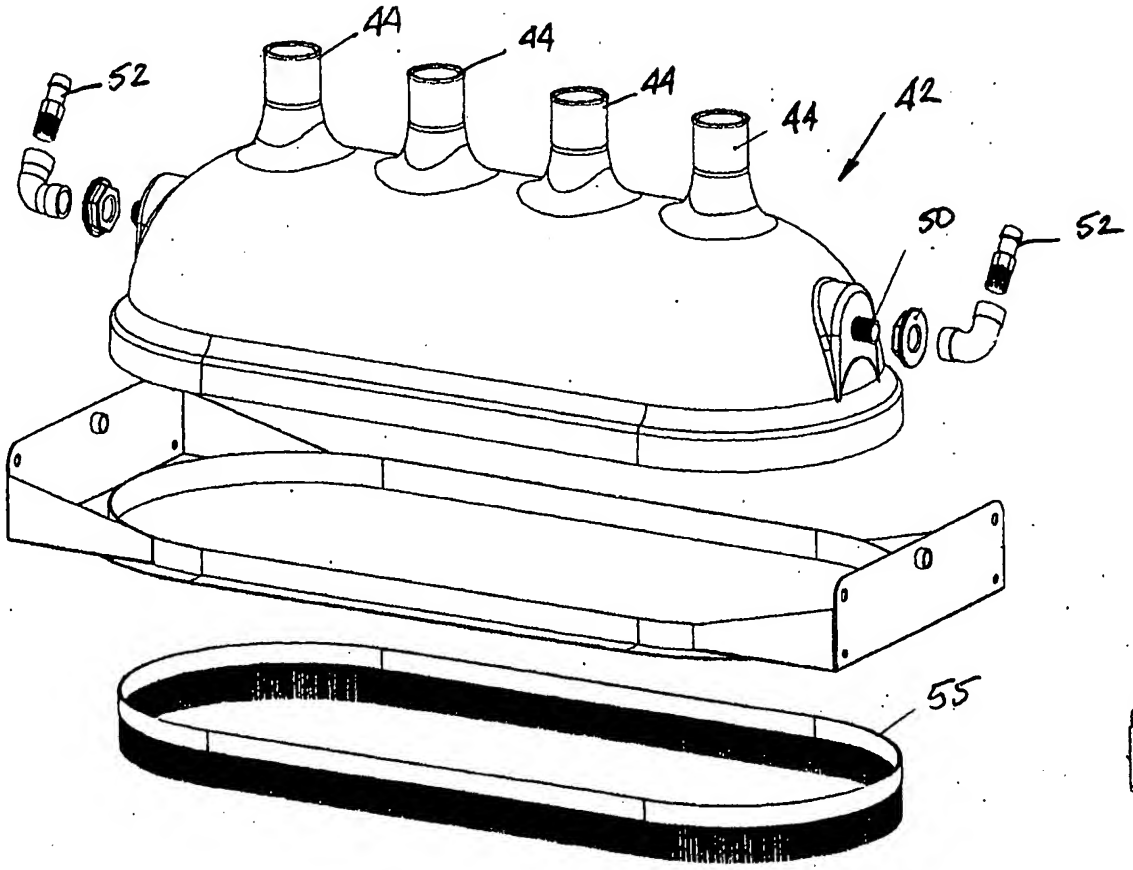


FIG. 13

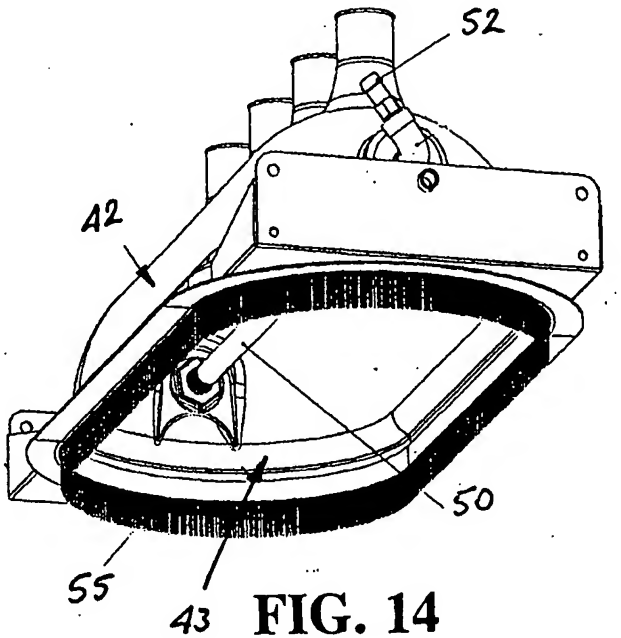


FIG. 14

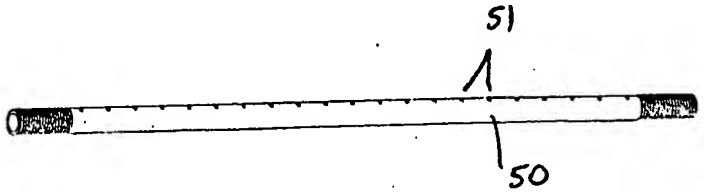


FIG. 15

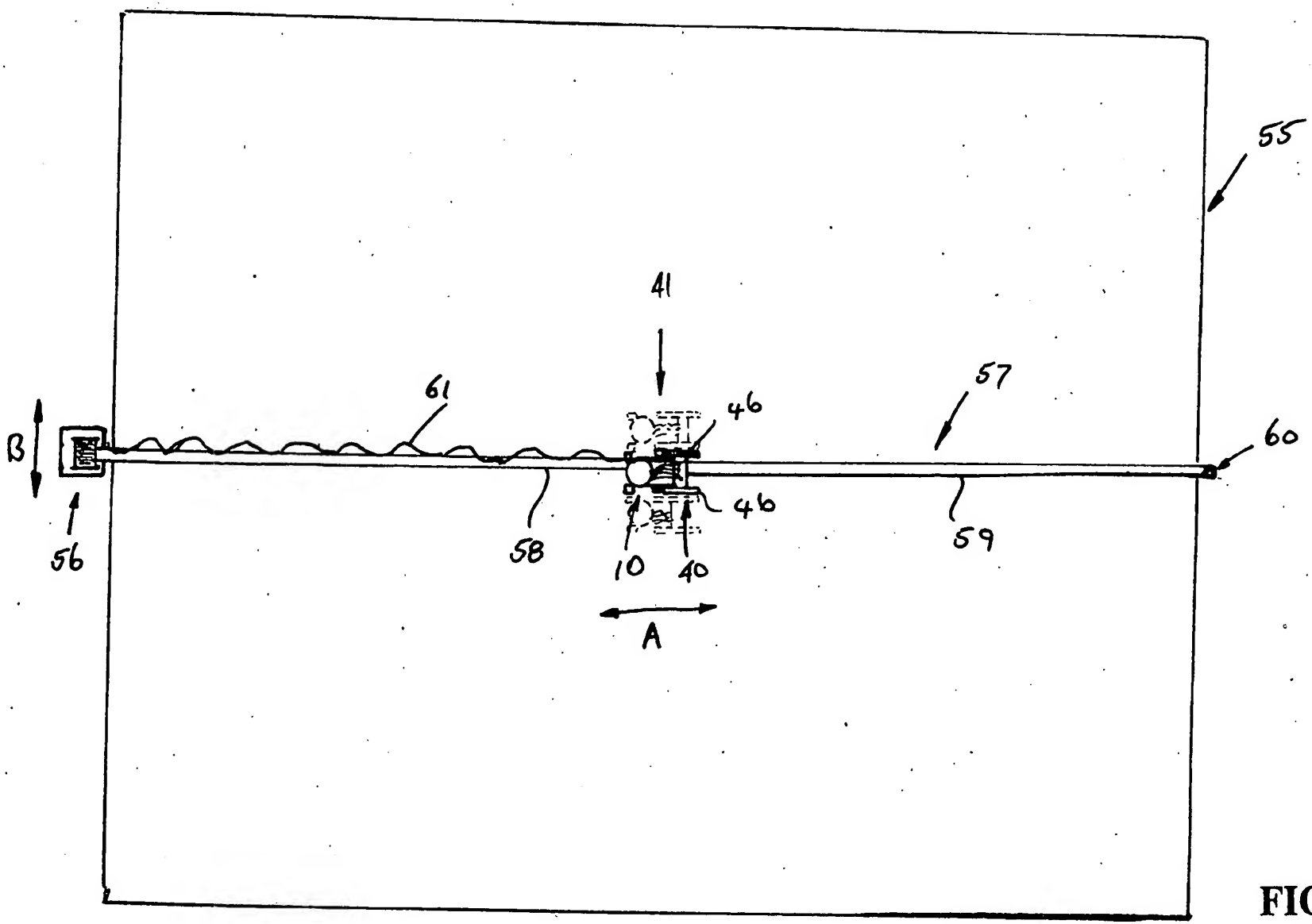


FIG. 16

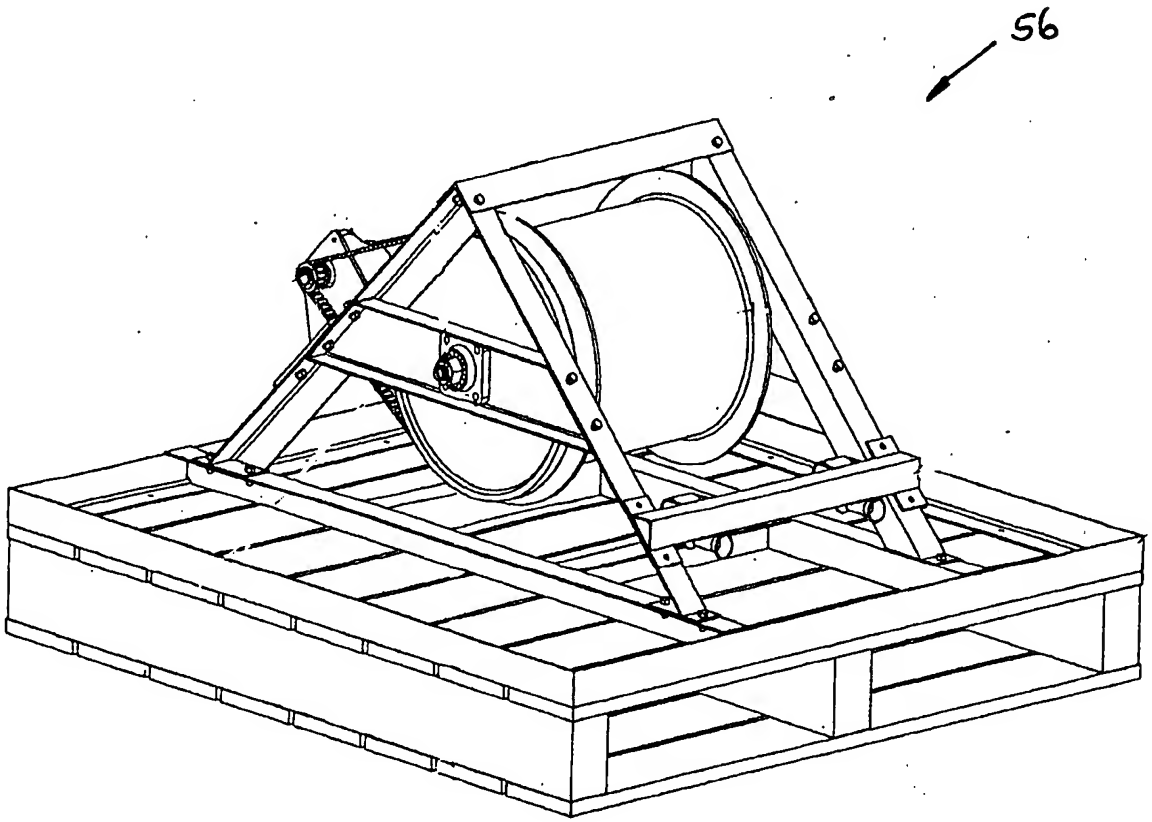


FIG. 17